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XVIII.—*On* Grantia ciliata, *var.* spinispiculum, *Crtr.*

By H. J. Carter, F.R.S. &c.

[Plate VIII.]

Having lately (September 1883) had occasion to collect a few of the Calcispongiæ which grow upon the rocks and seaweed about this place (Budleigh-Salterton, South Devon), I found it necessary to refer to Dr. Bowerbank's 'Monograph of the British Spongiadæ' to ascertain if I had among them any specimens of the *Grantia ciliata* illustrated in his third vol. (pl. ii. figs. 1–15), which appears to me to be typically that described and illustrated by Dr. Johnston in his 'History of British Sponges' (p. 176, pl. xx. fig. 4, and pl. xxi. figs. 6 and 7). Of this the type specimen is in the Johnstonian collection in the British Museum (no. 30, registered 47. 9. 7. 79), evidencing Montagu's remark respecting this sponge, which Johnston has quoted, viz. "that the specific character of being 'surrounded at top by a crown of spines' is rarely identified" (*op. et loc. cit.*). This is also shown in Dr. Bowerbank's illustration (*op. et loc. cit.* pl. ii. figs. 1 and 3); but in his description of this species (*op. cit.* vol. ii. p. 24) he refers for further particulars to his first paper on "The Organization of *Grantia ciliata*," viz. that in the 'Transac-

tions of the Microscopical Society' (vol. vii. p. 79, pl. v.), where the illustrations of the *entire* sponge (figs. 1 and 2) are quite different from those in the third volume of his 'Monograph.'

These differences were observed by Häckel in 1870, when he made two species of them under the name of *Sycandra ciliata* for the former and *S. coronata* for the latter ('Die Kalkschwämme,' vol. ii. pp. 296 and 304, and 'Atlas,' Taf. li. and lviii. and Taf. li. and lx.). But it does not seem to have influenced Dr Bowerbank in 1874, although the Rev. A. M. Norman, who edited the posthumous volume of his work (vol. iv., 1882), adopts the separation (p. 230).

However, after carefully reading and comparing Häckel's description of *Sycandra* (*Grantia*) *ciliata*, *S. coronata*, and *S. raphanus* respectively (vol. ii. p. 296 *et seq.*), together with the specimens of the two former found here, it appears to me that they run into each other in such a way that, although there may be grounds for making a separate species of the latter, I, with the late Dr. Bowerbank, see none for separating specifically the two former. The differences that exist between *Sycandra ciliata* and *S. coronata* appear to me to arise chiefly from the circumstances under which they have grown, viz. whether this has taken place in strong currents or comparatively still water, which, on account of the extreme brittleness and delicacy of the finer and longer spicules on the surface of the body, leads to their being more or less broken off. If these spicules have been retained entire, they are generally so matted together in the dried specimen as to obscure the conuli from which they proceed and thus give the surface of the body a shaggy ("zottig," H.) character; while those of the peristome or mouth may be more or less worn away, thus corresponding with Johnston's type specimen, Dr. Bowerbank's illustrations (vol. iii. *l. c.*), and my own experience here; but if, on the other hand, the finer and longer spicules of the conuli have been broken off, while the shorter and stouter ones which succeed them inwards remain, which is generally the case, then the conuli will of course be exposed, and the peristome remaining intact, we shall get a specimen like that represented by Dr. Bowerbank in the 'Transactions of the Microscopical Society' (*l. c.*), the former being Häckel's *Sycandra ciliata* and the latter his *S. coronata*. As to specific differences being deduced from the measurements of spicules and even the entire forms themselves of sponges, these are so variable generally that it is only here and there that they afford any trustworthy evidence.

But there is a difference in structure between *Sycandra*

ciliata and *S. coronata* on the one hand and *S. raphanus* on the other, which may, if constant, claim specific distinction for the latter; I allude to the prismatic form of the radial chambers in *S. raphanus*, whose transverse section made longitudinally to the body, midway between the surface of the cloaca and the conuli, presents a *hexagonal* arrangement with triangular spaces between the hexagons, first noticed by Häckel in his synoptical table of these sponges (*op. cit.* vol. ii. p. 294), while in *Sycandra ciliata* and *S. coronata* a similar section shows the chambers to be *circular* or cylindrical. How far this is sufficiently persistent to justify specific separation I am not prepared to state.

Carefully comparing Häckel's description of *Sycandra raphanus* with the species that prevails here, which in all respects agrees with that from the north of Shetland which I have named "*Grantia ciliata*, var. *spinispiculum*" ("Sponges dredged on board H.M.S. 'Porcupine,'" 'Annals,' 1876, vol. xviii. p. 468, pl. xii. figs. 6 and 7), I can see no difference between the two except in the presence of the spiniferous spicules in the latter, to which I shall presently allude, but which Häckel does not notice *at all* either in his descriptions or illustrations, although F. E. Schulze a few years later illustrated and described them particularly in *Sycandra raphanus* (Zeitschrift f. wiss. Zoologie, 1875, Bd. xxv. 3es Suppl. pp. 254 and 255, Taf. xix. fig. 1, *a–d*).

Now the fact of such spinous spicules having been found in *Sycandra raphanus* compared with their presence here in *Grantia spinispiculum*, whose structure otherwise corresponds exactly with Häckel's description of the former, leads me to infer that *Grantia spinispiculum* and *Sycandra raphanus* are the same, while the prismatic form of their radial chambers (and, perhaps, the spiniferous spicules) alone distinguishes them from *Sycandra ciliata* and *S. coronata*. It is the identity or not of the two former which I wish to be confirmed, as I do not possess a type specimen of *Sycandra raphanus* from the Adriatic for comparison; and therefore shall give hereafter an illustrated description of *Grantia ciliata*, var. *spinispiculum*, in all its principal detail, not only for this purpose, but to illustrate the variety itself, which hitherto has not been done.

In alluding to the acerate spicules which form the outer layer of the "collar-ring" noticed by Lieberkühn in "*Grantia ciliata* sive *Sycon ciliatum*" (Archiv f. Anat. u. Physiologie, July 1859, Heft iii. p. 373), and subsequently by Bowerbank (Trans. Microscop. Soc. *l. c.* p. 82), Häckel observes (*op. cit.* vol. ii. p. 308) that they are not to be found in *Grantia*

ciliata (" bei *S. ciliata* fehlen "), which I fancy must be a mistake, as from microscopical examination of specimens now before me I must agree with Lieberkühn and Bowerbank in affirming that the collar-ring (" Halsring," H.) in all three (that is including *S. raphanus*) commences where the conuli on the surface *outside*, and therefore the oscules of the radial chambers on the surface of the cloaca *inside*, cease and ends where the corona proper or circle of long, straight, setaceous, simple spicules commences (Pl. VIII. fig. 2, *h*), and that this layer of comparatively thick acerate spicules externally may be more or less present, according to the wear and tear above noticed to which the specimens may have been subjected. How far we may be justified in identifying with *Sycandra raphanus* the specimens of *Grantia ciliata*, var. *spinispiculum*, which I have lately found here, the following illustrated description, as above suggested, may determine.

Grantia ciliata, var. *spinispiculum*. (Pl. VIII. figs. 1–8.)

Pyriform elongated, fixed by the small end to the object on which it may be growing, terminated at the large or free end by an asbestine glistening pencil of long straight spicules; conulated over the surface, which is also ciliated with fine long spicules, inclined forwards and often presenting an asbestine sheen, like that of the pencil of spicules at the free end; more or less inflated and bent upon itself, often dividing into two heads, that is bigeminate (Pl. VIII. figs. 1 and 2). Colourless or transparent white. Consistence fragile. Surface uniformly covered with conical processes in juxtaposition (fig. 2, *a a a*), whose framework is composed of triradiate spicules, terminating towards the point of the cone in a slightly extended ray, which, intermingling with a bunch of linear spicules consisting of *fifty or more* of variable length, altogether forms the ciliary covering of the body just mentioned. " Bunch of linear spicules " composed of six forms, viz. :—1, extremely slender, almost immeasurably thin, straight, smooth, almost imperceptibly tapering outwards from an equally slight enlargement of the proximal end, in shape something like knitting-needles (" Stricknadeln," H.), in bundles scantily dispersed among the larger acerates, variable in length, averaging perhaps about 1-85th inch long, but seldom found entire from their delicacy. 2, short, fusiform, slightly curved and spined over one or both sides of the distal portion, which is terminated by a short smooth spur turned in the opposite direction, varying in length about 1-461st of an inch, which is that of the shortest observed (fig. 3, *c*). 3,

short straight acerates, minutely spined or serrated also over their distal portion, sharp-pointed, or terminated by a pin-like inflation at the distal end; shortest form seen about 1-300th of an inch (fig. 4, *c* and *d*). 4, long, straight, smooth, slightly tapering from a more or less slightly enlarged lanceolate or simply pointed proximal end to a curved free extremity, about 1-300th inch in length, serrated over the convexity and ending in a sharp smooth spineless point, which is turned in the opposite direction; serratures more or less distinct and in many instances evidently directed *outwards*, diminishing in size towards either extremity, the whole spicule varying in length from 1-461st of an inch, which is that of the smallest above mentioned, to 1-6th inch, which may be the maximum length of the longest (fig. 3). 5, like the last in form, but *straight throughout*, terminating in a very fine point, serrated on one side only, in two approximated broken lines, for about the same length as the foregoing, but with the teeth much larger and directed *inwards*, diminishing in size to the distal extremity as they increase in size in the opposite direction; length variable, viz. from about 1-300th of an inch, which is that of no. 3 above mentioned, to 1-23rd inch, which is the maximum of that observed (fig. 4). 6, gently curved once or twice, variable in length, but much shorter than the foregoing; smooth and pointed in the inner or proximal portion, serrated and abruptly or capitately terminated at the other; teeth as in the foregoing, on one side only, *recurved* and arranged in two approximated broken lines extending backwards for about 1-333rd inch from a slightly inflated head with 0–3 spines, directed *backwards* like the anchoring-spicule of *Euplectella*; length of longest observed about 1-36th inch (fig. 5). All these forms in *front* of the *stem* are directed forwards, and in all not only is the length very variable, as may be seen from the measurements above given, but the serration or spination and general form also are much modified, especially in the smaller kinds (nos. 2 and 3), while in the larger and longer (nos. 4 and 5) they are more persistent; and while no. 4 prevails towards the larger end of the body, the more distinctly spined or toothed spicules, nos. 5 and 6, together with 2 and 3, prevail towards the root. Peristome, vent, or mouth, as it has unfortunately been termed, composed of two portions, viz. a "neck" or "collar" (fig. 2, *h*) and a "crown" (fig. 2, *g*), the "collar" consisting of a contracted portion of the body about 1-60th inch in longitudinal diameter, naked or uncovered by the conuli, which do not extend further forward than this point, and thus the distinction is clearly defined; composed outside of a layer of stout, smooth,

slightly curved, fusiform, sharp-pointed acerates, about as long as the collar is broad (fig. 2, *h*), arranged longitudinally side by side, with their convexities inwards, and supported inside by a layer of tri- and quadriradiate spicules continuous with that of the surface of the cloaca, and equally armed by the projecting spur of the quadriradiate, although of course deficient in the holes of the radial chambers, which cease at the commencement of the structure externally and internally. "Crown" consisting of a circular row of long, straight, smooth, almost cylindrical spicules, about 1-18th inch in length, arranged longitudinally side by side, tapering slightly towards their free extremities from an equally slightly enlarged and pointed end which penetrates for some distance the distal margin of the collar, and on issuing thus forms a fringe or pencil of setaceous spicules that, when together, present the asbestine sheen above noticed, and, finally, may be expanded or approximated as required. Internal or body-structure (fig. 2, *e e*) composed of radiating prismatic chambers in juxtaposition, which extend transversely from the conuli that form their extremities on the surface to that of the plane of the cloaca internally (fig. 2, *f f*), supported throughout by the interlacing of tri- and quadriradiate spicules, which are so disposed in their course as to present a hexagonal form separated by small triangular interspaces externally (fig. 2, *d d*), and on the surface of the cloaca, so as to leave a number of holes corresponding in regularity to the chambers of the body (fig. 2, *m*), each of which is provided with a sphinctral diaphragm of sarcode just inside the margin (fig. 6, *b*). Stem (fig. 2, *i*) very variable in length, often obsolete, composed of a solid cylindrical mass of the tri-, quadriradiate, and linear spicules above mentioned, extending from the bottom of the cloaca to the object on which the sponge may be growing, and, of course, as destitute of the conuli and the radial chambers as the collar of the peristome. Root (fig. 2, *k*) presenting a group of tri- and quadriradiate spicules, from each of which an arm of variable length, below 1-60th of an inch, is considerably extended backwards and longitudinally, tapering at first and then ending in a more or less inflated lanciform extremity; surrounded by a fringe of short and long spiniferous or toothed spicules recurved or directed backwards, such as have been described under nos. 3, 5, and 6, most of which, but especially the latter (whose proximal ends are more or less lanceolately inflated, their length greater, and their teeth larger than those about the body), have their extremities fixed in their own or the indurated sarcode of some other neighbouring organism, which adheres to the rock (fig. 8) and thus forms the "root" or final

bond of attachment. Pores in the spaces between the conuli on the surface (fig. 7, *b*). Excretory canal-system consisting of the radial chambers, which have been described before as opening into the cloaca through sphincter apertures (fig. 6, *a b*), and the cloaca itself, which, occupying the centre of the body, consists of a cylindrical cavity corresponding in shape with the specimen, that is, narrow behind and wide in front, commencing in a blind point close to the stem, and ending in a wide mouth at the collar (fig. 2, *lll*); surfaced uniformly with circular holes, which are the oscular vents of the radial chambers above mentioned, arranged with corresponding regularity (fig. 2, *m*), and would be in juxtaposition but for the intervention of the spicular structure of the body, from which projects the fourth arm of the cloacal quadriradiates that are curved and directed forwards (fig. 2, *n*) ; limited in front by a sarcodic sphincter which separates the collar from the cavity of the cloaca. Size of specimen variable according to age and situation ; average of that above described, which grows a little below high-water mark on the rocks here (fig. 1), about 4-12ths inch long by 1-12th inch in its broadest part, not including the lateral spicules, which, as above stated, vary under 1-6th inch in length.

Hab. Marine. On *Fuci* near low-water mark, or abundant on the under surface of New Red Sandstone rocks a little below high-water mark. In company with an equal abundance of the following Calcispongiæ, viz. *Grantia clathrus*, *G. compressa*, *Leuconia Johnstonii*, *L. fistulosa*, and *Leucogypsia Gossei*, together with the common littoral siliceous sponges *Halichondria panicea* and *H. sanguinea*.

Loc. Budleigh-Salterton, south coast of Devon.

Obs. It is evident that a longitudinal section of the body across the radial chambers of this variety shows, as Häckel has stated respecting *Sycandra raphanus* (*op. et loc. cit.*), that its chambers are " hexagonal " in contradistinction to those of *Grantia* (*Sycandra*) *ciliata* and *G.* (*S.*) *coronata*, which are circular ; but, as before stated, what these differences may amount to from a specific point of view, as they may easily graduate into each other under the circumstances, I am not prepared to say ; nor am I able to state how far the longer spicules with spinous extremities may be absent in these two forms, as Häckel does not mention any, and my own specimens, which are all *dry*, fail to show them ; for they are either broken off or so inextricably clotted together by hardened sarcode as to defy all attempts at disassociation ; but the spines certainly do not appear on the shorter linear ones of the cone specimens which remain in these, while they do so on

most of the shorter linear ones of *Grantia spinispiculum*, although even here there may be an admixture of both kinds. At the same time long, stout, terminally curved spicules of a similar form, but *smooth throughout* (that is, without spines and not so much bent at the ends), may be more or less plentiful in the conular "bunches" of *Grantia ciliata* and *G. coronata*; wherein the chief differences between these and those of the variety *G. spinispiculum* appear to me to consist.

The capability of entirely closing the cloaca, which is essentially the "rectum" or termination of the excretory canal-systems in *all* hollow sponges, whether calcareous or siliceous, by the extension of a sarcodic, sphinctral diaphragm across the mouth at the junction of the body with the collar-ring, first noticed by Bowerbank in *Grantia ciliata* (Trans. Micros. Soc. 1859, vol. vii. p. 83), although not so plainly seen as that provided for the opening of each radial chamber into the cloaca, together with the relationship of the ends of the cones, which, although closed in the dried state by a kind of spiral twist of the linear spicules ("monoceles," H.) around their apices, respectively, would appear to have an opening here in the living one, is a mechanism which I cannot understand, seeing that the inhalent channels which lead to the chambers are on their outer side, as distinctly indicated by the pores themselves in the triangular interspaces between the conuli on the surface (Pl. VIII. fig. 7). That the single tubular vent projected from the young *Spongilla* when grown from the statoblast does close up for a time after a surfeit of *carmine*, I have long since witnessed and described ('Annals,' 1857, vol. xx. p. 30, pl. i. fig. 1); and if the sphinctral membrane at the base of the collar-ring acts in connexion with the conuli and sphinctral diaphragms of the radial chambers in *Grantia ciliata* and its varieties, they being all parts of the *excretory* canal-system, then the same kind of general closure may take place as in the young *Spongilla* under similar or other circumstances.

To attempt to describe all the varieties of form in the spicules of the sponge would be vain, from their great number, hence they can be only learned by a practical examination. To assign the use of the spined spicules too would appear to be wholly conjectural from their almost general distribution over the whole surface of the body, had we not a parallel case in the young spherical *Geodia* &c., wherein the anchoring-spicules ("anchors" and "forks") are developed over the whole of the surface, but for the most part only retained in a *projected* state where the *Geodia* is nearest to the object to which it may be attached, when they come into use for

anchoring-purposes, while those in the more exposed parts are more or less broken off. Such appears to be the case in *Grantia ciliata*, var. *spinispiculum*. The capitate spiniferous or denticulated spicules (Pl. VIII. fig. 5) would appear to be particularly adapted for this purpose; but they are by no means so numerous as the pointed ones (fig. 4), neither are they a bit more confined to the root, while the *capitate* portion itself appears to arise from a modification of the end of the spiniferous portion of fig. 4, in which the substance of the latter becomes retracted into an inflation, which may be simply round ('Annals,' 1876, vol. xviii. pl. xii. fig. 8), or provided with two or three recurved spines like that of the anchoring-spicule of *Euplectella*, as above stated. Hence I cannot agree with Schulze (Zeitschrift f. wiss. Zool. Bd. xxv. 3es Suppl. p. 255) in deriving this from a quadriradiate spicule.

The hardy nature of the Calcispongiæ, which are so much more fragile and delicate in structure than the siliceous sponges, is very remarkable here, where the roof of the cavern in the New Red Sandstone rock at "Straight Point" is just now absolutely covered with a mixture of all the species above mentioned, together with the siliceous species, viz. *Halichondria panicea* and *H. sanguinea*, Johnst., although it is only a few feet below high-water mark, and must be wholly uncovered by the sea for several hours twice a day, during which, of course, the sponges are kept wet by the dripping from the rock of the sea-water, which has also twice a day been absorbed during the time that it has been under water. Thus, high-water mark is not less characterized by the well-known littoral siliceous species with linear, than calcareous sponges with triradiate spicules.

I would here remark that to examine satisfactorily *Grantia ciliata*, var. *spinispiculum*, great delicacy of manipulation is required, otherwise most of the long spicules will inevitably be broken off, if they have not already suffered much in this way by the waves in their natural element. Thus it will be found advisable to bring away a portion of the rock on which they are growing and place it in spirit then or afterwards, to examine this carefully *under water* at home, to raise the root with a spatuliform needle most carefully, and to transfer to a slide for microscopical examination or subsequent mounting in balsam (N.B. which does not show an acid reaction with test-paper) the parts that are required, by means of capillary attraction, through a pipette. In this way the spiculation may be seen *in situ*; but when the *entire* spicules of different parts are required, then such portions of the body as might yield them are to be boiled separately, in *liquor potassæ*, until they

become disintegrated; the liquor poured off and the residuum in the watch-glass washed *twice only* with pure water, most carefully draining throughout, lest the minute spicules be carried away by the edulcoration; then the last drop containing the spicules should be transferred to a glass slide and drained again, but *not to perfect dryness*; now add one or two drops of glycerine, and secure the whole under a large glass cover, finally adding a little balsam at the cardinal points to keep it from slipping. This process has the advantage of preserving all the spicules, small and great, and, from their not having been reduced to absolute dryness, of preventing that crystallization of the remaining potash around them which otherwise would inevitably obscure their forms, while it yields a preparation which can be recurred to for deliberate examination as long as it may be required.

P.S.—A delicate spiniferous spicule, to which attention has not hitherto been directed, exists all over the surface of *Leucogypsia Gossei*, often fringing the mouth too in the manner of a peristome. It is fusiform, slightly curved, and spined proximally, chiefly over one side only, while the free extremity is armed, bayonet-like, with a short, delicate, smooth, slightly curved spur.

EXPLANATION OF PLATE VIII.

Note.—The representations in this Plate must (with the exception of fig. 1, which is of the natural size) be regarded as diagrams drawn to scale, that the reader may be able to realize as far as possible the relative proportions of the different parts of which fig. 1 is composed. Thus fig. 2 has been drawn to the scale of about 1-96th to 1-1800th inch, and even here the scale is not sufficiently large to show the spines on the spicules; so these, viz. 3, 4, and 5, have been drawn to the scale of 1-24th to 1-6000th inch; while for perspicuity also figs. 6 and 7 are magnified to double the size of the same parts in fig. 2.

Fig. 1. *Grantia ciliata*, var. *spinispiculum*, Crtr., single and double. Natural size.

Fig. 2. The same. *a a a*, body; *b*, peristome and collar; *c*, stem and root; *d d*, cones on the surface, direct view; *e e*, the same, lateral view, showing their connexion with *f f*, the radial chambers; *g*, peristome; *h*, collar; *i*, stem; *k*, root; *l l l*, dotted line showing the form of the internal cavity or cloaca; *m*, openings of the radial chambers into the cloaca; *n*, projection of the fourth ray of the quadriradiates of the cloaca into that cavity.

Fig. 3. The same. Spined spicule of the cone with *curved* free extremity, about 1-13th inch long. *a*, inflated, smooth, or proximal end; *b*, curved, serrated or distal end; *c*, shortest form seen, about 1-461st of an inch. Teeth directed *outwards*.

Fig. 4. The same. Spined spicule of the cone and root, with a *straight* free extremity, about 1-23rd inch long. *a*, inflated, smooth, or proximal end; *b*, straight, toothed, or distal end; *c*, shortest

straight specimen seen; and *d*, shortest *capitate* specimen seen, each about 1-300th inch long. Teeth directed *inwards*.

Fig. 5. The same. Capitate spined spicule of the cone and root, about 1-36th inch long. *a*, smooth, sharp-pointed, or proximal end; *b*, spined and capitate or distal end. Teeth recurved.

Fig. 6. The same. Diagram of four radial-chamber vents, to show the sarcodic sphincters in them respectively. *a*, vent; *b*, sarcodic sphincter.

Fig. 7. The same. Diagram of seven cones, to show the position of the pores in the triangular spaces between them. *a*, cone; *b*, pore.

Fig. 8. Sand-grains of the rock on which the variety has grown.

XIX.—*Some Preliminary Remarks on the Gemmules of the Freshwater Sponges.* By Dr. William Marshall*.

The gemmules of the freshwater sponges, as is well known, present in the constitution of their envelopes a series of very remarkable peculiarities, which are very different according to the species, and which, as adaptations, must have very special causes and significations.

Each germ possesses, according to the species, a round or oval, sometimes convexo-concave shell, furnished with one opening, or (in *Spongilla multiforis*, Cart.) with one principal and several subordinate apertures, through which the mature contents issue at the proper time. The innermost layer of this shell is a firm structureless membrane, which Carter † describes as chitinous ("*chitinous coat*"), by which, no doubt, is meant only that it is "horny," without reference to its chemical constitution.

In some few kinds of gemmules this innermost simple thin layer is alone present; in others the wall is thicker, and appears sometimes very peculiarly modified. Thus in *Spongilla nitens* (according to Carter's ‡ and my own observations) and in *S. Carteri* (according to Carter) we see that the thick capsule is not homogeneous, nor does it show that constitution which Carter calls "granular cell-structure." Under a low power it appears in section to be finely striated radially, and its surface, like that of the eye of an insect, appears divided up into elegant convex equilateral hexagons; by the employment of higher powers we discover that the lines of striation are not the expression of hexagonal corneous pyramids di-

* Translated by W. S. Dallas, F.L.S., from the 'Zoologischer Anzeiger,' 1883, pp. 630-634 and 648-652.

† Ann. & Mag. Nat. Hist. ser. 5, vol. vii. p. 83.

‡ *Loc. cit.*